

R marks

The specification of Patent '561 discloses a broad range of thickness for the protective layer (or for each individual protective layer).

Column 8, lines 27 to 31, of Patent '561 states:

"The individual protective layers are typically 1 nm thick, preferably from 40 to 200 nm thick and exhibit in particular a thickness which is a fraction e.g. $\lambda/2$ or $\lambda/4$ of the wavelength of the radiation to be reflected."

[Emphasis supplied]

The thickness of the protective layer can be $\lambda/2$ or $\lambda/4$ of the wavelength of the radiation.

Column 8, lines 52 to 56, of Patent '561 states:

"The reflective layer c) on the reflector body via layer b) serves in particular to reflect energy in the form of waves and/or particles, usefully for reflecting radiation having wave lengths in the optical range, preferably visible light, in particular that having wave lengths of 400 to 750 nm."

[Emphasis Supplied]

Therefore, an example of the thickness of the protective layer is 375 nm, i.e., $\lambda/2 = 750 \text{ nm}/2$. Note that a thickness of 375 nm is larger than 200 nm, the upper value of the preferred thickness range.

Patent '561 discloses reflection of "energy in the form of waves".

Needless to say, such disclosure covers all of the types of encompassed radiation or energy in wave form, and their ranges of wave length. The types of energy in the form of waves and their ranges of wave length are in the literature

and known to one skilled in the art. The wave lengths at the lower and higher points of such ranges supply further examples, by means of $\lambda/2$ and $\lambda/4$ calculation, of the disclosed thickness of the protective layer.

The specification of Patent '561 provides further examples of the thickness of the protective layer, namely, 1 nm, 40 nm, 200 nm, 100 nm, (i.e., $400/4$), 200 nm (i.e., $400/2$) and 187.5 nm (i.e., $750/4$).

Patent '561 further states:

“The reflectors according to the invention having surfaces that bear such a reflective layer or multilayer system exhibit excellent reflectivity for example of electromagnetic radiation, especially electromagnetic radiation in the visible light range. The optical range includes e.g. infra-red range, the visible light range, ultra violet etc. The preferred range for application is that of electromagnetic radiation and thereby the visible light range.”

[Emphasis Supplied] [Col. 9, lines 24 to 31]

The radiation to be reflected includes electromagnetic radiation with some emphasis on the “optical range”, that includes infrared light, visible light and ultra violet light. Patent '561 states:

“The present invention includes also the use of reflectors having a surface resistant to mechanical and chemical attack and high total reflectivity for the reflection of radiation in the optical range i.e. daylight and artificial light, thermal radiation, visible light, ultra violet light etc. Of particular importance is the use of reflectors for reflecting visible light in

particular daylight or artificial light, including UV light." [Emphasis

Supplied] [Col. 10, lines 5 to 12]

Thermal radiation wave lengths come within the wave length range of the optical range. Patent '561 states:

"Layers a) produced this way can be produced with a precisely prescribed layer thickness, pore-free, homogenous, and with regard to the electromagnetic radiation, transparent, in particular in the visible and/or infra-red range." [Emphasis Supplied] [Col. 4, lines 63 to 67]

Patent '561 states:

"The metallic reflective layer (13), or layer system comprising metal reflecting layer (17) and protective layers (16), is deposited on the functional layer (12). A ray of light (15) penetrates the transparent protective layers (16), which are sketched in here and are in particular transparent, and is reflected by the metal reflecting layer (17)." [Emphasis Supplied] [Col. 10, lines 35 to 40]

"For that reason the reflectors according to the invention are suitable e.g. as reflectors such as those for radiation sources or optical equipment. Such radiation sources are e.g. lights such as work-place lights, primary lights, secondary lights, strip lights with transvers reflectors, light elements, lighting covers, light deflecting fins or thermal radiators. The reflectors may also e.g. be mirrors or internal mirrors in optical equipment, lighting components or thermal radiators." [Emphasis Supplied] [Col. 10, lines 34 to 42]

Infrared light has a range of wave length of 780 to 300,000 nm.

Encyclopedia Britannica, Micropaedia, Vol. V, (1974), page 353, (copy enclosed), states:

“infrared light, that portion of the electromagnetic spectrum adjacent to the long wave length, or red end of the visible light range....The infrared range is usually divided into three regions: near infrared (nearest the visible spectrum), with wavelengths 0.78 to 5.0 microns (a micron, or micrometre, is 10^{-6} metre); middle infrared, with wavelengths 3 to 30 microns; and far infrared, with wavelengths 30 to 300 microns. Most of the radiation emitted by a moderately heated surface is infrared light; it forms a continuous spectrum.” [Emphasis Supplied]

Therefore, examples of the thickness of the protective layer are 1,500 nm (i.e., 3,000/2), 750 nm (i.e., 3,000/4), 15,000 nm (i.e., 30,000/2), 7,5000 nm (i.e., 30,000/4), 150,000 nm (i.e., 300,000/2), and 75,000 nm (i.e., 300,000/4).

Ultraviolet light has a range of wavelength of 10 to 380 nm. Encyclopedia Britannica, Micropaedia, Vol. X, (1974), page 247, (copy enclosed), states:

“ultraviolet light, that portion of the electromagnetic spectrum adjacent to the short wavelength, or violet end of the visible light range. ...The ultraviolet spectrum is usually divided into two regions: near ultraviolet (nearer the visible spectrum), with wavelengths 2000 to 3800 angstrom units (one angstrom is 10^{-10} metre, or 0.1 nanometre); and far ultraviolet, with wavelengths 100 to 2000 angstrom units.” [Emphasis Supplied]

Therefore, examples of the thickness of the protective layer are 2.5 nm (i.e., 10/4), 5 nm (i.e., 10/2), 100 nm (i.e., 200/2) and 50 nm (i.e., 200/4).

One skilled in the art would consider the numerical range of 1 nm to 150,000 nm for the thickness of the individual protective layers to be inherently supported by applicants' original disclosure. MPEP 2163.05 states:

"III. RANGE LIMITATIONS"

"With respect to changing numerical range limitations, the analysis must take into account which ranges one skilled in the art would consider inherently supported by the discussion in the original disclosure. In the decision in *In re Wertheim*, 541 F2d 257, 191 USPQ 90 (CCPA 1976), the ranges described in the original specification included a a range of '25% - 60%' and specific examples of '36%' and '50%.' A corresponding new claim limitation to 'at least 35%' did not meet the description requirement because the phrase 'at least' had no upper limit and caused the claim to read literally on embodiments outside the '25% to 60%' range, however a limitation to 'between 35% and 60%' did meet the description requirement."

Entry of the amendment is requested as the finality of the Office Action is premature, as shown above.

The amendment filed on July 2, 2002 has been objected to under 35 U.S.C. 132 because it introduces new matter into the disclosure. Applicants traverse this objection.

The preliminary amendment was mailed by certificate of mailing dated June 26, 2002, which is therefore the date it was timely filed in the Patent Office, See Rule 8. The actual date received by the patent Office was apparently July 2, 2002. Applicants will use the latter date for conformity of reference (as per Rule 8).

The Office Action stated 35 U.S.C. 132 states that no amendment shall introduce new matter into the disclosure of the invention. New matter has not been inserted by amendment, as shown previously and below.

Nothing was amended by the preliminary amendment filed on July 2, 2002, so this objection is in error. Therefore, the Examiner has prematurely gone final. Applicants request that the final status of the Office Action be withdrawn and that a new nonfinal Office Action be issued (if the application is not allowed).

The Examiner has objected to the wrong amendment. The amendment that amended the specification is the one made at the time the reissue application was filed (i.e., July 5, 2001) by physically incorporating the change into the specification. 37 CFR 1.173 (b) states:

“(b) Making amendments in a reissue application. An amendment in a reissue application is made either by physically incorporating the changes into the specification when the application is filed, or by a separate amendment paper. If amendment is made by incorporation, markings pursuant to paragraph (d) of this section must be used. If amendment is made by an amendment paper, the paper must direct that specified changes be made.” [Emphasis Supplied]

The Office Action stated: that, in reference to the objection of the amendment filed on July 2, 2002 under 35 U.S.C. 132, because it introduced new matter in the disclosure, applicants argue that the Preliminary Amendment dated July 2, 2002 (not as dated June 26, 2002 which appears to be in error) did not amend anything but instead set out the basis for the amendment in the specification when the reissue application was filed; and that on this ground alone this objection is in error. Applicants traverse this statement and refer to Rule 173(b). While applicants disagree with the ground of the objection, applicants point out that the objection should have been to the amendment to the specification at the time the reissue application was filed. The present objection to the preliminary amendment, filed on July 2, 2002, is defective because the preliminary amendment did not amend anything.

The date of the preliminary amendment was June 26, 2002 because that is the date of the certificate of mailing – the date of July 2, 2002 is the date it was filed via the fiat of the second sentence of Rule 8.

The Office Action stated: that the Examiner agrees with applicants that the Preliminary Amendment filed on July 2, 2002 did not amend the specification; that, however, there is no amendment in the file to show when and how the specification was amended; and that, if the Preliminary Amendment filed on July 2, 2002 did not amend the specification, the applications should provide when and how the specification was amended. The specification of the reissue application was amended on the date (i.e., July 5, 2001) that the reissue application was filed and that, pursuant to Rule 173(b), the specification was

made by physically incorporating the change into the specification when the reissue application was filed. The language of Rule 173(b) provides the basis for identifying the amendment under discussion.

The Office Action stated that the added material which is not supported by the original disclosure is as follows: column 8, lines 28, changing the phrase “protective layers are typically 1 nm thick” to the phrase – protective layers are typically from 1 nm thick – introduces new matter because the addition of the word “from” to the phrase allows the thickness range of the protective layers to open ended while the original phrase limits to “1 nm thick protective layers.” Applicants traverse this statement because new matter is not involved.

Dependent Claim 12 in U.S. Patent No. 5,919,561 (Patent ‘591) states:

“12. The reflector according to claim 1, wherein the reflective layer (c) is a multilayer system comprising a reflecting layer and deposited on that transparent protective layers with different refractive indices.” [Emphasis supplied]

Dependent Claim 12 does not recite any thickness or thickness range for the transparent protective layer or layers. The thickness of the transparent protective layer in dependent claim 12 is “open ended” in both directions. This shows that the disclosure of Patent ‘591 teaches that the upper side of the thickness (range) of the transparent protective layer can be so-called “open ended”. It would be obvious to one skilled in the art that the recitation “typically 1 nm thick” was an error and illogical when the transparent protective layer was “preferably from 40 to 200 nm thick”. One skilled in the art would not typically use a one nm

thickness when the preferred thickness is from 40 to 200 nm (the preferred thickness being at least 40 fold greater than the typical thickness). It is illogical and against the practice in the packaging/material/chemical fields and the patent filed to have the typical thickness being a single point value that is very far outside of the preferred range and does not cover the preferred range. The practice in the art is for the general/typical range to encompass the preferred range. One skilled in the art would readily ascertain the obvious error, and would readily see that the open endedness in dependent Claim 12 provided for the correction of the error (and remove the illogic situation caused by the subject error). The rule in *In re Oda et al.* is thereby followed and complied with by correcting the error to recite “typically more than 1 nm thick”. The disclosure of Patent ‘591 directs the correction of the subject error caused by the translation error.

Dependent Claim 13 in Patent ‘591 states:

“13. The reflector according to claim 1, wherein the reflective layer (c) is a multilayer system comprising a reflecting layer and deposited thereon transparent protective layers with different refractive indices, the reflective layer being 10 to 200 nm thick and each of the transparent protective layers being 40 to 200 nm thick.”[Emphasis supplied]

This is the preferred thickness range. It is clearly illogical to one skilled in the art that the typical thickness (range) would not encompass the preferred thickness (range).

The pattern of the recitation of the thickness of the transparent protective layer in column 8 of Patent '591 also supports the amendment as not being new matter. Column 8, lines 28 and 29, recites "... are typically [?] 1 nm thick, preferably from 40 to 200 nm thick..." [Emphasis supplied] That sentence also evidences that its structure would be missing the word "from" the typical thickness range recitation (which is in line with the open endedness of dependent Claim 12).

The pattern used by the other thickness ranges in Patent '561 has the preferred or advantageous thickness ranges within the span or scope of the general or typical thickness ranges – see column 2, lines 64 to 66, (reflector bodies), column 3, lines 19 to 34, (pre-treatment layer), column 5, lines 50 to 59, (aluminum oxide layer), and column 9, lines 13 to 15, (oxide-containing bonding layer).

Roman Fuchs is one of the joint inventors in U.S. Patent No. 5,919,561 (the patent for which this reissue application was filed). Column 1, lines 34 to 46, of Patent '561 discusses the disclosure of European Published Application No. 0495755 A1 (European '755). Roman Fuchs is also one of the joint inventors in European '755. The publication date of European '755 is in July 1992.

The discussion of European '755 in Patent '561 discloses objects having an aluminum surface, upon which is sequentially located a bonding layer (e.g., a ceramic layer), a light-reflecting layer (e.g., a metallic layer, e.g., aluminum), and "one or more transparent protective layers of metallic compounds".

European '755 is based upon Swiss Patent Application No. 68/91 (filed on January 1, 1991). U.S. Patent No. 5,403,657 (Patent '657), 5,527,572 and 5,663,001 each claim the priority of Swiss Patent Application No. 68/91 and each has the effective U.S. filing date of December 23, 1991. The first two mentioned U.S. patents have publication dates before applicants' U.S. filing and Swiss priority filing dates. Roman Fuchs is one of the joint inventors in all three of such U.S. patents.

All three of such U.S. patents have the same disclosure as that of European '755 of objects having an aluminum surface, upon which is sequentially located an optional adhesive layer (e.g., a metallic layer), and at least one transparent protective layer (e.g., of various metallic compounds). The following discussion of Patents '657 equally applies to the other two of such U.S. patents.

Column 3, lines 44 and 45 , of Patent '657 states:

“The individual layers are typically 1 to 200 nm, preferably 1 to 100 nm thick.”

One skilled in the art and joint inventor Roman Fuchs use typical thickness ranges that span or encompass preferred thickness ranges. It is illogical otherwise and would indicate an obvious error to one skilled in the art.

A copy of U.S. Patent Nos. 5,403,657, 5,527,572 and 5,663,001 and European Published Patent Application No. 0495755 A1 was earlier supplied. The knowledge possessed by one skilled in the art can be established by

reference to patents available to the public before applicants' filing date – see *In re Lange* (that involved a new matter issue).

The Office Action stated that applicants are required to cancel the new matter in the reply to this Office Action. Applicants traverse this requirements because no new matter is involved.

This objection should be withdrawn.

Claims 1 to 15 have been rejected under 35 U.S.C. 251 as being based upon new matter added to the patent for which reissue is sought. Applicants traverse this rejection and have shown herein that new matter is not involved.

The Office Action stated that the added material which is not supported by prior patent is as follows:

Column 8, lines 28, changing the phrase “protective layers are typically 1 mn thick” to the phrase – protective layers are typically from 1 nm thick – introduces new matter because the addition of the word “from” to the phrase allows the thickness range of the protective layers to be open ended while the original phrase limits to “1 nm thick protective layers”.

Applicants traverse this statement. The added material is supported by the disclosure of Patent '591 and the knowledge of one skilled in the art. In *re Oda et al.* and *In re Lange* support applicants' position that new matter is not involved. The Examiner's position is clearly in error and unsupported by the evidence.

The applicants' discussion and evidence above under the objection are incorporated here so as not to be redundant.

The Office Action stated: that, in reference to the new matter rejection, applicants points to the C.C.P.A., *In re Lange*, 644 F.2d 856, and *In re Oda et al.*, 170 USPQ 268 (C.C.P.A. 1971), and argue that the dependent Claim 12 does not recite any thickness or thickness range for the transparent protective layer or layers; that the thickness of the transparent protective layer in dependent Claim 12 is “open ended” in both directions; that this shows that the disclosure of U.S. Patent No. 5,919,561 teaches that the upper side of the thickness (range) of the transparent protective layer can be so-called “open-ended”; that it would be obvious to one skilled in the art that the recitation “typically 1 nm thick” was an error and illogical when the transparent protective layer was “preferably from 40 to 200 nm thick”, that one skilled in the art would not typically use a one nm thickness when the preferred thickness is from 40 to 200 nm; that applicants also points to U.S. Nos. Patents 5,403,657, 5,527,572 and 5,663,001 wherein one of joint inventors Roman Fuchs of this Patent No. 5,919,561 is also a joint inventor and these patents disclose individual layers are typically 1 to 200 nm, preferably 1 to 100 nm thick, and that, thus, one skilled in the art and joint inventor Roman Fuchs use typical thickness ranges that span or encompass preferred thickness range. Applicants’ points and positions are correct and show that no new matter is involved.

The Office Action stated: that these arguments are unpersuasive because the recited cases are related to the typographical errors, which are different that in the instant case. Applicants traverse this statement. The cases relied upon by applicants are apropos to the issues at bar. The Preliminary Amendment

presented analysis and evidence that one skilled in the art would appreciate that the error was present, what the error was and how to correct it – this meets the requirements of *In re Oda et al.* so the amendment did not involve new matter. Applicants have herein, and in the 3/12/03 amendment, presented further reasons and evidence to show that new matter is not involved. Applicants have complied with the requirements of *In re Oda et al.* and *In re Lange* to show by reasons and evidence that new matter is not involved. Furthermore, under the circumstances of the case at bar the Board *Ex parte Boudious* decision is not controlling or even apropos. The later decisions of *In re Oda et al.* and *In re Lange* of the C.C.P.A. are the controlling and apropos decisions.

The Office Action stated that, in Claim 12, the thickness of the protective layer is not recited and therefore it is open ended argument is unpersuasive because, when thickness is not recited in the claim, one skilled in the art would use the disclosure as a dictionary to find thickness. This statement is partially incorrect. One skilled in the art, when looking at Claim 12, would be guided by the disclosure to look for the thickness, including the extremes of the thickness range, that provide operable results, process, product, etc., and that fulfill the objects and purposes of the claimed invention. Applicants have above shown disclosure support for range and many examples. The Examiner's statement is incorrect in law and fact.

The Office Action stated that, in the instant case, the protective layer(s) can be either 1 nm thick or from 40 to 200 nm thick. Applicants traverse this statement in view of the examples shown above.

The Office Action stated that there is no evidence showing that the thickness of the protective layer can be higher than 200 nm, that are encompassed by the open-ended limitation. Applicants traverse this statement and have shown above that the evidence shows larger thickness.

The Office Action stated that, further, there is no affidavit of fact by an expert providing showing that the thickness of the protective layer can be open-ended. This statement is not pertinent. The inherent examples show a thickness of 150,000 nm, etc. No expert declaration is necessary as applicants' disclosure shows and supports the claims and the amendments to the specification.

The Examiner has misanalyzed the *In re Oda et al.* decision and incorrectly attempted to limit *in re Oda et al.* to its particular set of facts. *In re Oda et al.* expressly sets out the broad principles and procedures for determining if any particular amendment does or does not constitute new matter. Specifically, *In re Oda et al.* states:

"On all the evidence, we conclude that one skilled in the art would appreciate not only the existence of error in the specification but what the error is. As a corollary, it follows that it is also known how to correct it.

We therefore disagree with the board's first conclusion that the change of 'nitrous' to 'nitric' is 'new matter.'"

"We also think there is adequate evidence in the record to show that the error in saying 'nitrous' instead of 'nitric' was a translation error."

[Emphasis supplied] [Page 272]

In re Oda et al. dealt with a translation error and set out the principles and

procedures of how to determine whether or not new matter was present. The Examiner has not followed the analysis, principles, etc., required by *In re Oda* et al. (and *In re Lange*). The present objection and rejection are defective. For example, the Examiner did not deal with or mention the following from the Preliminary Amendment:

“The error was that the translator left the word ‘from’ out of the phrase ‘are typically from 1 nm thick, preferably from 40 to 200 nm thick’ (in German). One skilled in the art would know that an error was present in the phrase ‘are typically 1 nm thick, preferably from 40 to 200 nm thick.’ That is, it appears to be an error to say that the (each) transparent protective layer typically has a thickness of 1 nm when the preferred thickness range is from 40 to 200 nm. Note that Claim 12 does not contain any thickness value or range for any of the transparent protective layers of reflective layer (c). [Emphasis supplied] [Page 1 and 2]

The Examiner’s attention is also drawn to the following:

M.P.E.P. 2163 states:

“While there is no *in haec verba* requirement, newly added claim limitations must be supported in the specification through express, implicit, or inherent disclosure. An amendment to correct an obvious error does not constitute new matter where one skilled in the art would not only recognize the existence of the error in the specification, but also recognize the appropriate correction. *In re Oda*, 443 F.2d 1200, 170 USPQ 268 (CCPA 1971).” [Emphasis Supplied]

This summarization of In re Oda et al. is incorrect because In re Oda et al. states:

“As a corollary, it follows that when the nature of this error is known it is also known how to correct it.” [Emphasis supplied] [Page 272]

M.P.E.P. 2163.05 states:

“With respect to changing numerical range limitations, the analysis must take into account which ranges one skilled in the art would consider inherently supported by the discussion in the original disclosure.”

The Examiner has erroneously, without any justification, attempted to restrict the application of In Re Oda et al. to the specific or type of fact situation involved in In Re Oda et al. As applications have shown above, In re Oda et al. is not so restricted. In re Oda et al. sets out broad principles and procedures to be used in determining whether or not new matter is involved. In re Oda et al. is not limited to its specific facts or factual type of situation. Furthermore, In re Lange stated that one skilled in the art and such person’s knowledge (as shown, for example, by prior patents) had to be considered and examined in determining if new matter was or was not present.

This reissue application seeks to reissue U.S. Patent No. 5,919,561 to correct an error which resulted from the translation into English of the German language priority Swiss patent application. The translator erroneously did not translate the German word “von” so the English translation comprising the U.S. application underlying U.S. Patent No. 5,919,561 left out the English word “from.” The details are set out in the reissue application declaration (and supplemental declaration) and the declaration of the translator, both of record.

The mistranslation sought to be corrected does not involve any claim or claim limitation or any preferred range. The error in the specification was that the translator left the word “from” out of the phrase “are typically from 1 nm thick, preferably from 40 to 200 nm thick” (in German). One skilled in the art would know that an error was present in the phrase “are typically 1 nm thick, preferably from 40 to 200 nm thick.” That is, it appears to be an error to say that the (each) transparent protective layer typically has a thickness of 1 nm when the preferred thickness range is from 40 to 200 nm. Note that Claim 12 does not contain any thickness value or range for any of the transparent protective layers of reflective layer .

In the case of *In re Oda et al.*, 170 USPQ 268, (C.C.P.A. 1971), mistranslations were made in preparing the U.S. application in English from corresponding Japanese applications. The patentees in such instance filed a reissue application to correct the U.S. patent. The C.C.P.A. ruled that correction of such mistranslation was not “new matter” and allowed the compound claims of the reissue application. The translator’s error in the case at bar is clearly analogous and comes within the *In Re Oda et al.* doctrine. There is more than adequate and convincing evidence in the record to show that no new matter is involved.

This rejection should be withdrawn.

Reconsideration, reexamination and allowance are requested.

Respectfully submitted,

10/21/03
Date

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ship, for they believe that the enjoyment of the sound would detract from the meaning of the words of the hymns.

Radha Soamis of Beas: see Radha Soami Satsang.

Rādha-Vallabhis, a small Hindu sect founded by Harivamśa in the 16th century that stressed the worship of Rādha, regarded as the wife of Lord Kṛṣṇa (Krishna). The sect originated in Vrndāvana, near Mathurā, the scene of Kṛṣṇa and Rādha's legendary exploits, and the chief temples of the cult are still located there. In employing the symbolism of the divine lovers, the sect conceived of Kṛṣṇa as Lord, and Rādha as the human soul. One of the forms of worship was to impersonate in dress and behaviour the female Rādha as a way of experiencing the longing of the human soul for God.

Rādī, ar- (reigned 934-940), Muslim 'Abbāsīd caliph.

decline of caliphal power 3:638h

radial artery, artery in the arm associated with the radius.

human cardiovascular system anatomy 3:882f

radial curve, in mathematics, if through a fixed point rectilinear segments are drawn equal and parallel to the radius of curvature of a variable point of a given curve C, the locus of the end points of those segments is the radial curve R of C.

analytic geometry fundamentals 7:1093a

radial lip seal, an oil or shaft seal, probably the most commonly used.

design and construction 11:255e; illus.

radial nerve, nerve in the arm associated with the radius.

anatomic relationships and functions 12:1023e

radial symmetry, in biology, arrangement of similar parts of the body in circular fashion around a central axis, as in starfishes, sea urchins, sea anemones, coral polyps, and jellyfishes, all animals of a more or less attached existence, at least in some stage of their life cycle.

echinoderm evolution and body form 6:181g

Metazoan body plan evolution 14:381d

radial vein, vein in the arm associated with the radius.

human cardiovascular system anatomy 3:883h

radial velocity, in astronomy, the relative motion of a celestial body in the line of sight toward or away from an observer. Radial velocity can be measured because light emitted or reflected from a moving body is shifted in wavelength (and colour) by the Doppler effect; i.e., a star moving away from the observer will appear to him to be redder than if the star and the observer were motionless relative to each other. Conversely, if the star and observer are moving closer together, the starlight will appear bluer; i.e., shifted to longer wavelengths. Differences in radial velocity measured at the opposite edges (limbs) of a body, such as the Sun or a planet, can reveal how fast it is rotating. Velocities in the line of sight are measured for planets, stars, nebulae, galaxies, quasi-stellar objects—in fact, for any type of object for which a spectrum with recognizable lines can be obtained.

radar detection of moving target 15:373b

spectroscopic determination method 2:236g

star cluster motion and orbit 17:606c

stellar motion determination 17:587a; illus.

Radiance of the King, The (1956), translation of *Le Regard du Roi* (1954), novel by Camara Laye.

theme and Kafka comparison 1:239f

radian measure, in geometry, is, together with degree measurement, one of the two

common ways of measuring angles and is the preferred in both mathematics and physics. The radian measure of an angle is defined to be the length of the arc of a circle of radius one with centre at the vertex inscribed by the angle. An angle of 180 degrees is the same as an angle of $(\pi) \pi$ radians.

dimensional analysis theory 14:422b

mathematical calculation theory and use 11:675g

trigonometry principles and development 7:1082b

radiant, in astronomy, the apparent point of origin of celestial bodies (stars in a cluster, or meteors in a shower) moving toward the observer along parallel paths. Perspective causes the parallel paths to appear to originate at a point, as the parallel lines of a railroad track or highway may appear to meet at the horizon. Stars in a cluster, moving away from Earth on parallel courses, appear because of perspective to be moving toward a convergent point.

radiant energy, energy that is transferred by electromagnetic radiation, such as light, X-rays, gamma rays, and thermal radiation, which may be described in terms of either discrete packets of energy, called photons, or continuous electromagnetic waves. The conservation of energy law requires that the radiant energy absorbed or emitted by a system be included in the total energy.

astronomical photometry

measurements 14:349c

disease causation and symptoms 5:853h

electromagnetic wave properties 6:644h

spectra emission principles 17:457d

radiant heating, raising the temperature of a space by admission of infrared energy, usually supplied by panels mounted in the floor, walls, or ceiling, and heated electrically or by circulating steam, hot air, or hot water. The effectiveness of radiant heating does not depend on efficient circulation of air or direct contact with the heat source.

building heating design 3:465f

central heating technology 8:718g

human comfort factors 8:711h

Radiata, in former biological classifications, a major category of invertebrates including forms having the parts arranged radially about an axis.

echinoderm and coelenterate groupings 6:178a

radiation, either the process of emitting electromagnetic energy (heat, light, gamma rays, X-rays, etc.), subatomic particles (electrons, neutrons, protons, alpha particles, etc.), or the energy or particles thus emitted. Certain forms of radiation, particularly gamma rays, protons, and alpha particles, cause ionization in substances that they strike, and terms such as radiation chemistry, radiation biology, radiation pathology, and radiation physics refer to the study of the effects of these ionizations upon chemical substances, living matter, disease processes, and physical systems.

air pollution and climatic effect 5:50b

atmospheric science principles 2:321c

Bragg's study of rays dual property 3:102h

classifications and characteristics 15:399b

cosmological explanation of background levels 18:1008d

electromagnetic wave properties 6:644h

energy transport phenomena 18:676g

environmental levels and sources 14:756g

glacier development variables 9:176a

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RELATED ENTRIES in the *Ready Reference* and

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photodynamism; photorecovery; target theory

radiation, thermal, the process by which energy, in the form of electromagnetic radiation, is emitted by a heated surface in all directions and travels directly to its point of absorption at the speed of light; thermal radiation does not require an intervening medium to carry it.

The thermal radiation ranges in wavelength from the longest infrared rays through the visible light spectrum to the shortest ultraviolet rays. The intensity and distribution of radiant energy within this range is governed by the temperature of the emitting surface. The radiant heat energy emitted by a surface varies as the fourth power of its absolute temperature T (the Stefan-Boltzmann law).

The rate at which a body radiates (or absorbs) heat energy depends upon the nature of the surface as well. Objects that are good emitters are also good absorbers (Kirchoff's radiation law). A blackened surface is an excellent emitter as well as an excellent absorber. If the same surface is silvered, it becomes a poor emitter and a poor absorber. A black body (q.v.) is one that absorbs all radiant energy that falls on it. Such a perfect absorber would also be a perfect emitter.

The heating of the Earth by the Sun is an ample of transfer of heat by radiation. The heating of a room by an open-hearth fire is another example. The flames, coals, and bricks radiate heat directly to the room, heating the room with little of this heat being

common ways of measuring angles and is the one preferred in both mathematics and physics. The radian measure of an angle is defined to be the length of the arc of a circle of radius one with centre at the vertex inscribed by the angle. An angle of 180 degrees is the same as an angle of (π) radians.

-dimensional analysis theory 14:422b
-mathematical calculation theory and use 11:675g
-trigonometry principles and development 7:1082b

radiant, in astronomy, the apparent point of origin of celestial bodies (stars in a cluster, or meteors in a shower) moving toward the observer along parallel paths. Perspective causes the parallel paths to appear to originate at a point, as the parallel lines of a railroad track or highway may appear to meet at the horizon. Stars in a cluster, moving away from Earth on parallel courses, appear because of perspective to be moving toward a convergent point.

radiant energy, energy that is transferred by electromagnetic radiation, such as light, X-rays, gamma rays, and thermal radiation, which may be described in terms of either discrete packets of energy, called photons, or continuous electromagnetic waves. The conservation of energy law requires that the radiant energy absorbed or emitted by a system be included in the total energy.

-astronomical photometry measurements 14:349c
-disease causation and symptoms 5:853h
-electromagnetic wave properties 6:644h
-spectra emission principles 17:457d

radiant heating, raising the temperature of a space by admission of infrared energy, usually supplied by panels mounted in the floor, walls, or ceiling, and heated electrically or by circulating steam, hot air, or hot water. The effectiveness of radiant heating does not depend on efficient circulation of air or direct contact with the heat source.

-building heating design 3:465f
-central heating technology 8:718g
-human comfort factors 8:711h

Radiata, in former biological classifications, a major category of invertebrates including forms having the parts arranged radially about an axis.

-echinoderm and coelenterate groupings 6:178a

radiation, either the process of emitting electromagnetic energy (heat, light, gamma rays, X-rays, etc.), subatomic particles (electrons, neutrons, protons, alpha particles, etc.), or the energy or particles thus emitted. Certain forms of radiation, particularly gamma rays, protons, and alpha particles, cause ionization in substances that they strike, and terms such as radiation chemistry, radiation biology, radiation pathology, and radiation physics refer to the study of the effects of these ionizations upon chemical substances, living matter, disease processes, and physical systems.

-air pollution and climatic effect 5:50b
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The rate at which a body radiates (or absorbs) heat energy depends upon the nature of the surface as well. Objects that are good emitters are also good absorbers (see Kirchhoff's radiation law). A blackened surface is an excellent emitter as well as an excellent absorber. If the same surface is silvered, it becomes a poor emitter and a poor absorber. A black body (*q.v.*) is one that absorbs all the radiant energy that falls on it. Such a perfect absorber would also be a perfect emitter.

The heating of the Earth by the Sun is an example of transfer of heat by radiation. The heating of a room by an open-hearth fireplace is another example. The flames, coals, and hot bricks radiate heat directly to the objects in the room with little of this heat being an-

sorbed by the intervening air. Most of the air that is drawn from the room and heated in the fireplace does not re-enter the room in a current of convection (*q.v.*) but is carried up the chimney together with the products of combustion.

-galactic nebula radio emission 7:332f
-heat exchangers for spacecraft use 8:708b
-heat theory and principles 8:703d
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-infrared radiation properties 6:652b
-solar radio emissions 15:463g
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radiation absorbed dose: *see* rad.

radiation belt, inner, part of a doughnut-shaped region surrounding the Earth at the geomagnetic equator that contains high-energy protons and electrons that are "trapped" in the Earth's magnetic field. The existence of this zone of high intensity of charged particles, which was detected by the U.S. satellites Explorers 1 and 3 in 1958, has been studied extensively by a group at the University of Iowa under the leadership of James A. Van Allen. The inner belt is one of the Van Allen radiation belts, the other being the outer.

These zones of charged particles exist in a region beginning at an altitude of about 800 kilometres (500 miles) and extend out to about eight to ten Earth radii (the equatorial radius of the Earth is approximately 6,378 kilometres, or 3,963 miles). There appear to be two peaks in the density of the charged particles, the first occurring at about 1.5 Earth radii out from the Earth's centre and the second one occurring between three and four Earth radii. These have come to be called the inner and outer radiation belts, respectively.

The inner belt appears to be composed primarily of protons, the source of which is currently thought to be the neutron component of a process called neutron albedo. In this process, cosmic rays from outside the Earth's atmosphere strike the atmosphere and produce neutrons by a variety of nuclear collisions. A certain fraction of these neutrons then diffuses upward, out of the atmosphere, decaying into protons and electrons in the radiation belt. This process is generally believed to contribute most or all of the high-energy trapped protons in the inner zone.

radiation belt, outer, part of a doughnut-shaped region surrounding the Earth at the geomagnetic equator that contains high-energy protons and electrons that are "trapped" in the Earth's magnetic field.

The outer radiation belt extends from roughly two Earth radii (the equatorial radius of the Earth is approximately 6,378 kilometres, or 3,963 miles) out to eight to ten Earth radii from the Earth's centre and together with the inner radiation belt (*q.v.*) comprises the Van Allen radiation belts, named for the U.S. physicist James A. Van Allen. The peak radiation intensity occurs at a distance of about 3.5 Earth radii. Early measurements (1958) from satellites indicated that the outer belt was composed primarily of electrons; but later measurements from Explorer 12 (1961) indicated considerable abundance of protons, at least in the inner portions of the outer belt. Presumably, these protons are a continuation of the same population of protons comprising the inner belt.

The origin of the trapped particles in the outer belt is not yet completely understood, but some form of solar control appears to be necessary. One theory suggests that interactions between the solar wind (stream of gas originating from the Sun by eruptions on its surface and expansion of the solar atmosphere) and the Earth's geomagnetic field ultimately is the source of the trapped particles. Other complex theories have also been put forth. Among the unanswered questions are problems concerning the relationships of the outer belt with auroral displays and changes in the structure of the outer belt that take place during geomagnetic storms.

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